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Neutron capture measurements for nuclear astrophysics

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Almost all of the heavy elements are produced via neutron capture reactions in a multitude of stellar production sites. The predictive power of the underlying stellar models is currently limited because they contain poorly constrained physics components such as convection, rotation or magnetic fields. Neutron captures measurements on heavy radioactive isotopes provide a unique opportunity to largely improve these physics components, and thereby address important questions of nuclear astrophysics. Such species are branch-points in the otherwise uniquely defined path of subsequent n-captures along the s-process path in the valley of stability. These branch points reveal themselves through unmistakable signatures recovered from pre-solar meteoritic grains that originate in individual element producing stars. Measurements on radioactive isotopes for neutron energies in the keV region represent a stringent challenge for further improvements of experimental techniques. This holds true for the neutron sources, the detection systems and the technology to handle radioactive material. Though the activation method or accelerator mass spectroscopy of the reaction products could be applied in a limited number of cases, Experimental facilities like DANCE at LANL, USA and n-TOF at CERN, Switzerland are addressing the need for such measurements on the basis of the more universal method of detecting the prompt capture gamma-rays, which is required for the application of neutron time-of-flight (TOF) techniques. With a strongly optimized neutron facility at the Rare Isotope Accelerator (RIA) isotopes with half-lives down to tens of days could be investigated, while present facilities require half-lives of a few hundred days. Recent neutron capture experiments on radioactive isotopes with relevance for nuclear astrophysics and possibilities for future experimental setups will be discussed during the talk.